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硕　士　学　位　论　文

购买力平价理论的再回顾

The Purchasing Power Parity Puzzle:

A Re-examination

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摘 要

在国际宏观经济学诸多中心议题当中，购买力平价问题是个难题。十年之后，它的规划，即罗果夫所说的的购买力平价（PPP）问题仍然是个开放的问题。关于这个难题，虽然有着丰富的文献，但对于其理论解释或者关于最合适的方法来解释它，至今为止都没有达成一致。

本研究的目的在于使用新时期真实汇率（RERs）的数据集来衡量购买力平价（PPP）这个难题，同时也再次检验其在新兴市场（NEMs）当中的情况。为此研究，我们首先算出几个欧洲发展国家和新兴市场（NEMs）的实际汇率（RERs）。然后我们就检验购买力平价（PPP）在我们实际汇率（RERs）数据集中的有效性。之后，剩下的工作分下面这几步骤来完成：第一章、对于写这篇硕士论文的动机做个简要的介绍；列出每一章简要的内容。第二章、简要评述购买力平价（PPP）相关文献。第三章、提供检测购买力平价（PPP）方面的方法，以及估计一个半衰期购买力平价（PPP）理论的偏差。第四章、提供数据的描述。本章也涵盖了每个实际汇率（RERs）数据的图形演示。第五章、本章涵盖的主要内容是，实证结果。在这一章我们通过，根据实际汇率（RERs）对 21 种外币对一个单位根做个测试来找出购买力平价（PPP）的有效性。其中五种货币为欧洲发达国家的，其余 16 种为新兴市场的。如果购买力平价（PPP）存在于实际汇率当中，我们就可以假设实际汇率（RERs）有均值回复，也能够估计一个半衰期的购买力平价（PPP）理论的偏差。在第五章内，我们也会给出 ADF 测试在通常水平的结果以及第一阶的自我回归。AR (1)估计模式半衰期的偏差。最后，在第六章里，给出我们所有实证工作的结果。

关键词：购买力平价；实际汇率；单位根；PPP 难题；半衰期.

ABSTARCT

The purchasing power parity puzzle is among the central issues of international macroeconomics. A decade after its formulation, the so-called Rogoff's PPP puzzle is still an open question and, in spite of the abundant literature, no agreement has been reached regarding either its theoretical explanation or the most appropriate way to measure it.

The purpose of this paper is to use new period real exchange rates (RERs) data sets to measure the PPP puzzle and also re-examine the so-called Rogoff's PPP puzzle for the New Emerging Markets (NEMs). To do that, we first, calculate the RERs for several European development countries and NEMs. Then we examine the validity of PPP in our RERs data set. The rest of our works are distributed in the following way: Chapter 1 introduces a brief introduction and the motivations for this master thesis and provides a brief review of each chapter. Chapter 2 presents a brief review of the PPP-related literature. Chapter 3 provides the methodological aspects of testing the PPP and estimation for a half-life deviation from PPP. Chapter 4 provides data descriptions. Also this chapter covers graphical presentations for each of RERs. Chapter 5 provides the main part of our work that is, empirical results. In this chapter we test 21 dollar-based real exchange rates for a unit root to find validity of the PPP. Five RERs of them are European developed countries and sixteen are NEMs. If the PPP holds in the data we can suppose that RER has a mean reversion and estimate for a half-life of PPP deviation. In chapter 5, we also presented the results of ADF tests at conventional levels and first-order autoregressive, AR (1), estimation models for a half-life deviation. Finally, in chapter 6, we conclude all of our empirical works results.

Key Words: Purchasing Power Parity; Real Exchange Rates; Unit Roots; PPP puzzle; Half-life.

List of Acronyms

ADF test:	Augmented Dickey-Fuller test
ADF-GLS:	ADF test proposed by Elliot, Rothemberg and Stock (1996)
AR (*p*):	Autoregressive order *p* process
CPI:	Consumer price index
DGP:	Data generating process
HDR:	Highest density region approach
MCIM:	Monte Carlo integration methods
NEM:	New emerging markets
OECD:	Organisation for Economic Co-operation and Development
PPP:	Purchasing power parity
STAR:	Smooth transition autoregressive
WDI:	World Development Indicators
WTO:	World Trade Organization

Contents

Chapter 1 Introduction

1.1 Statement of Problem

International macroeconomics continues to have a menu of puzzles that require new theoretical and empirical explanations. Obstfeld and Rogoff (2000) have identified 6 major puzzles of international macroeconomics. Three of these relate to exchange rate economics. They are: the purchasing power parity (PPP) puzzle, the exchange rate disconnect puzzle, and the exchange rate determination puzzle. In our thesis we focus on consideration of the first one – the so called Rogoff's PPP puzzle.

Purchasing Power Parity (PPP) is a theory of exchange rate introduced by Gustav Cassel in the period after World War I to restore the world financial system after large-scale periods of inflation during and after the war. There are two versions of PPP. One is absolute PPP and the other is relative PPP.

The absolute version of PPP states that the nominal exchange rate, defined as units of the domestic currency per unit of the foreign currency, should be equal to the price ratio of domestic to foreign country. This version of PPP is based on the basic idea of the Law of One Price (LOP) that the same good should have the same price between two countries when measured in a common currency, under given conditions.

The relative version requires that changes in the nominal exchange rate should be equal to the inflation differential between the home and foreign countries. In other words, the rate of growth in the exchange rate offsets the differential between the rate of growth in home and foreign price indices.

Reviewing the literature on Purchasing Power Parity (PPP), Rogoff (1996) found, using single equation methods, a remarkable consensus on 3 to 5 year half-life estimates of real exchange rate (RER) deviations from PPP.[1] This is an important piece of Rogoff's *"PPP*

[1] In contrast to the view prevailing in the 1980's, in recent years a general consensus about the long-run holding of the purchasing power parity (PPP) has emerged. This consensus has been made possible by enhancing the power of unit root tests, either by considering longer spans of data for a single country (Taylor (2002), Lothian and Taylor(1996), Abuaf and Jorion (1990), etc.) or panels of several countries (see Wei and Parsley, (1995), Frankel and Rose, (1996), etc.)

puzzle" as the question of how one might reconcile highly volatile short-run movements of real exchange rates with an extremely slow *convergence rate to PPP.* The Purchasing Power Parity Puzzle was coined by Rogoff in original as follows:

"*How is it possible to reconcile the extremely high short-term volatility of real exchange rates with the glacial rate (15 percent per year) at which deviations from PPP seem to die out?"*

Rogoff (1996).

Furthermore, it has recently been argued that the reported 3-5 year half-lives are underestimated, implying that the puzzle is even bigger than was first thought. Murray and Papell (2002) have shown that traditional measures underestimate persistence because they rely on estimates of the AR parameter, which is known to be downwardly biased in finite samples if the data is highly persistent. Extending their analysis, López et al. (2003, 2004) have reported half-life estimates between 8 and 11 years, with lower bounds over 3 years and upper bounds that do not allow the rejection of the failure of the PPP.[2]

1.2 Objective of the Study

The main objective of this study is to investigate whether PPP holds on among countries in given periods and re-examine the "PPP puzzle" for 21 different dollar-based RERs. As we mentioned in above section it has been argued that the reported 3-5 year half-lives are underestimated, so we examine this for 5 developed and 16 New Emerging Markets (NEMs) using new period data sets.

1.3 Scope of the Study

This study intends to provide explanation the essence of PPP puzzle and examine the estimation for a half-life of PPP deviation based on real exchange rates.

[2] Similar conclusions have been reached by Cashin and Mcdermott (2003), Rossi (2003), Caporale et al. (2004) and Murray and Papell (2005).

For this study 16 new emerging markets and 5 developed countries' currencies, such as German mark, French frank, Italian lira, Spanish peseta and Canadian dollar, are selected. US Dollar is used as a base currency for all above currencies.

The real exchange rate can be calculated based on various aspects, for example, based on import or export price index, wholesale or producer price index (WPI or PPI) and consumer price index (CPI) as well. In this study, however, by availability of data, the real exchange rate will simply be calculated from the CPI index. Using the CPI index in examining PPP is also common in previous literature.

Nevertheless, as raised by Rogoff (1996), it should be noted that each country may have different basket weights in calculating CPI and this may affect the precision of our test. In addition, as traded goods prices constitute a larger weight in the CPI index, deviations from PPP will decline (Melvin and Bernstein, 1984). This study, however, will rely on CPI provided by the OECD and the World Bank as they are the best available choice and their constructions are similarly sufficient for empirical.

1.4 Organization of the Study

This study will be organized into six chapters. The first chapter consists of statement of the problem, along with the objective and scope of the study. The second chapter reviews empirical studies on testing and examination of "PPP puzzle". The theoretical framework and methodology are described in Chapter 3. Chapter 4 describes data sets and provides graphical presentations of RERs. Chapter 5 reports the empirical results of investigating PPP and estimations for half-lives of PPP deviation. Related analysis and discussions are also included in this chapter. The last, chapter 6 presents major findings of this study and conclusions.

Chapter 2 Literature Review

This chapter provides a broad picture of how empirical studies on the PPP puzzle were conducted. Major findings of those studies, along with advantages and limitations of each technique, will be summarized and discussed. The first part of this chapter focuses on traditional studies based on a time series approach. Then, the second part concentrates on studies using panel data. And the third part of this chapter provides a brief literature review on half-life version of the PPP puzzle.

2.1 Traditional Studies: Time Series Approach

Empirical study of PPP based on time series data focuses mainly on testing the stationarity of the real exchange rate. Stationarity of real exchange rate indicates mean reversion in the data of real exchange rate for a given period. This section focuses on traditional studies based on a time series approach.

In the first era, studies on PPP mostly relied on the time series properties of real exchange rates. Since the real exchange rate is defined as nominal exchange rate multiplied by the ratio of national price level and the PPP hypothesis postulates a proportional relation between the nominal exchange rate and the relative price ratio, this implies the real exchange rate has to revert to a constant level over time to satisfy PPP. Hence, numerous amounts of literature have attempted to test the mean reversion of PPP by employing a unit root test of real exchange rate for the post-Bretton Woods period of floating exchange rates. If the null hypothesis of unit root or non-stationarity cannot be rejected, then the real exchange rate does not show the reversion toward its own mean, indicating that PPP does not hold in the long run.

There has been limited evidence supporting PPP found in this era. As cited in previous literature[3], Roll (1979), Frankel (1981), Adler and Lehmann (1983), Darby (1983) failed to reject random walk of real exchange rate, implying that long run PPP did not hold. Even in recent studies, results do not tend to have any strong support for PPP. Coakley and Fuertes (1997) examined the real exchange rates of G10 countries and Switzerland between 1973 and

[3] Rogoff (1996),Flessig and Strauss (2000), Taylor and Taylor (2004) and Wang (2005).

1996. The results showed that conventional ADF test fails to reject the unit root null hypothesis for all real exchange rates which implies the rejection of PPP. The similar test was also applied to five developing Asian countries by Doganlar (1999). As expected, it led to the same conclusion.

The issue on the low power of test was raised that the failure to reject the random walk might be from a lack of power of standard tests. Frankel (1986, 1990) argued that using post-Bretton Woods data covering just 15 years (since 1973) may not have enough power to reject the existence of unit root even if it is indeed false. Though, over a long period of time, real exchange rate tends to revert to its mean, verification of real exchange rate's behavior in a relatively short time may not have sufficient information to detect its mean reversion. Therefore, he employed over hundred years of data from 1869 to 1984 and was able to find support for PPP. He also estimated the rate of mean reverts by 14 percent per year which meant a half-life for PPP deviation is 4.6 years.

Simulations of Lothian and Taylor (1997) and Sarno and Taylor (2002b), assuming the rate of mean revert of 11 percent per year, showed that the probability to reject unit root of real exchange rate, when it is indeed mean reverting, is around five to eight percent when using 15 years of data. To increase the chance of correctly rejecting the unit root, more data is required.

Unfortunately, Shiller and Perron (1985) have pointed out that increasing the frequency of data in order to increase the sample size will not increase the power of the test. More frequent data can not provide additional long run information but only give more information about short run movement.

Consequently, several studies based on long horizontal data have been conducted. In this era, more evidence in favor of PPP were obtained; for example, Glen (1992) using data for the years 1900-1987 found mean reversion of real exchange rates for nine countries and a half life of 3.3 years. Lothian and Taylor (1996) found strong evidence of mean reversion using two centuries of data on dollar-sterling and franc-sterling real exchange rates. The studies of Diebold, Husted and Rush (1991), Grilli and Kaminsky (1991) and Cheung and Lai (1994) yielded similar results.

In contrast, a smaller number of studies did not obtain confirmation of PPP. Baharumshah and Ariff (1997) and Weliwita (1998) failed to support long run PPP using cointegration tests. In another study, using a shorter period of time, Darius and Williams (2000) also found very little evidence to support PPP.

2.2 Cross Countries Studies: Panel Data Approach

Apart from expanding the range of years to enhance the power of test, the other choice is to use more countries so that the timeframe can be limited to the post-Bretton Woods period. By increasing the amount of information employed in the tests *across* exchange rates, the power of the test should be increased (Taylor and Taylor, 2004).

The study of Frankel and Rose (1996) pointed out that even when using only post-1973 floating data, the random walk model can be handily rejected, given that a sufficiently broad cross-section of the countries is included. Moreover, PPP deviations are eroded at a rate of approximately 15 percent annually, i.e., their half-life is around four years which is similar to results using long horizontal data. The panel approach is also adopted by Koedijk, Schotman and Dijk. (1998), Papell and Theodoridis (1998), Flores, Jorion, Preumont and Szafarz (1999), Chiu (2002) and Lopez and Papell (2007). All have reported similar findings, strong evidence in favor of long run PPP.

Moving from time series data to panel data, however, encounters issues of heterogeneity and cross-sectional independence. In the case of time series data, the unit root hypothesis is tested for each individual. Although the test models may differ for each individual, heterogeneity is not a problem as long as the tests are conducted separately. In contrast, when data is pooled in the panel, the panel unit root tests have to account for this heterogeneity. For the case of cross-sectional independence, it is rather restrictive and unrealistic in the majority of macroeconomic applications since co-movements of economies are often observed (Hurlin and Mignon, 2004). Therefore, various tests allowing for cross-sectional correlation have been developed.

According to whether unit root tests allow for potential correlation across residuals of panel units, panel unit root tests can be classified in two generations.

First Generation Panel Unit Root Test

The first generation of the panel unit root test is based mainly on the cross-sectional independence assumption. The panel unit root test (LLC test) proposed by Levin and Lin (1993) and Levin, Lin and Chu (2002) imposes an identical first order autoregressive coefficient on all series in the panel. Rejection of the null hypothesis implies that real exchange rates in all economies adjust at the same rate. They have also analyzed the power of panel unit root tests under the assumption of i.i.d. disturbances, and showed that it is an order of magnitude higher than in a univariate setting.

Later on, Im, Pesaran and Shin (2003) proposed a new panel unit root test (IPS test) allowing for heterogeneous first order coefficients under the alternative hypothesis so that series may adjust at different rates. This made this test become more realistic than that of the test by Levin and Lin (1993) and Levin *et al.* (2002). While the tests suggested by Levin and Lin (1993), Levin *et al.* (2002) and Im *et al.* (2003) focused on pooled and average statistic, Maddala and Wu (1999) and Choi (2001) proposed Fisher's type test based on combining the significant levels from the individual tests.

Alba and Park (2003) evaluated the existence of PPP on a panel of developing countries with 14 different country classifications based on openness, inflation experience, growth rate and per capita income. The overall period of 1976-1999 was divided into 15 moving periods with ten consecutive years. The unit root hypothesis could not be rejected in closed countries. This is sensible since PPP is applicable to open economies. For panels of developing countries that opened up trade, the unit root hypothesis is only rejected for some periods. In conclusion, this study did not give any assertion for PPP since the evidence of PPP was found in only 14 out of the 210 cases.

Second Generation Panel Unit Root Test

Since the tests of first generation suffer from size distortion and low power when applied to data with cross-sectional dependencies, the second generation of panel data unit roots tests relaxing the assumption of cross-sectional independence have recently been proposed in literature including Choi's (2006), Bai and Ng's (2004), Moon and Perron's (2004), Pesaran's (2003) and Phillips and Sul's (2003) tests.

Fleissig and Strauss (2000) asserted that accounting for cross correlation[4] positively affects stationarity and the half-life of deviation from PPP. This study evaluated PPP over the floating period (1974Q1-1996Q3) for six different price indices, including 19 economies and used the US as the benchmark. Applying Demeaned-IPS and O'Connell parametric bootstrap procedure, the results confirmed the validity of PPP.

Coakley and Fuertes (1997) adjusted for cross-sectional dependence to analyze the stationarity of real exchange rates for the G10 countries and Switzerland in the post-Bretton Woods period by the Demeaned-IPS test. This study strongly rejected the unit root and hence indicated mean reversion in real exchange rate and also found a half life of under three years for one-off shocks. An empirical study of Paul (2004), also reported results in favor of PPP when demeaned-IPS test was used.

Nevertheless, some investigations did not provide strong affirmation of PPP. For example, Engel *et al.* (1997) verified long run PPP allowing for correlation across equations in their panel and estimated the model using GLS and found no evidence in favor of reversion to PPP. Cerrato and Sarantis (2007) applied bootstrap panel unit root test allowing for heterogeneous serial correlation and different speeds of convergence, along with MW test and CIPS test. No evidence favoring mean reversion in real exchange rate was found for the full panel of OECD countries.

Koedijk, Tims and Dijk (2004) found mixed results in the euro area. Moreover, Drine and Rault (2007) applied unit root tests of Choi (2006) and Moon and Perron (2004) to investigate the PPP. It was reported that the null hypothesis of unit root in real exchange rate can be rejected only in OECD countries. In addition, when countries are classified into two subgroups depending on the exchange rate regimes, the strong version of PPP was also rejected for both fixed and floating exchange rate regimes. They argued that some factors leading to the rejection of PPP exist, such as, obstacles in international exchanges, long run capital movements and interventions on the exchange market.

It is worth noting that the cross-sectional dependence in panel data can be corrected not only

[4] Fleissig and Strauss (2000) found that correcting for both cross correlation and heterogeneity results in quicker mean reversion. In addition, allowing the heterogeneity of real exchange rates in panel positively affects speeds of adjustment and stationarity.

by the second generation of panel unit root tests, but also by using bootstrap methodology.

2.3 The Half-Life Version of the PPP Puzzle

Following Rossi (2005), consider that a real exchange rate follows an autoregressive process of order one such that $y_t - y_0 = \alpha + \rho(y_{t-1} - y_0) + u_t$, where y_0 is the long-run equilibrium value and u_t is white noise. At horizon h the percentage deviation from equilibrium is ρ^h. Then the half-life deviation is the smallest h such that:

$$h = \frac{\ln(1/2)}{\ln(\rho)}$$

Traditionally half-life deviations have been used for AR (1) processes. For higher orders, half-life can be calculated from the impulse response function of an AR (p) model given that the closed form solution does not exist.

The half-life version of the PPP puzzle is that a high degree of exchange rate volatility is generally associated with an implausibly slow speed of mean reversion. According to sticky price theories, a half-life of an exchange rate is supposed to be less than 3 years. However, according to Rogoff (1996), the consensus is that the speed of mean reversion is between three and five years. Other authors such as Grilli and Kaminski (1991) and Lothian and Taylor (1995)) have used approximately 100 years of annual data to find evidence of significant mean reversion, with an average half life across these studies being around 4 years. Diebold, Husted and Rush (1991) also used long time spans of annual data, ranging from 74 to 123 years, to analyse the real exchange rates of 6 countries using a fractional integration framework. They found evidence that PPP held as a long-run concept, generally reporting half-lives of around 3 years.

Taylor (2000) has noted possible pitfalls associated with the calculation of half-lives, the main problem being a downward bias in the magnitude of point estimates. Some of the problems have to do with the linearity assumption, the choice of sample frequency, and the treatment of nonlinearities. Clearly therefore the calculation of half-lives that are free of biases is challenging. Diebold, Husted and Rush (1991) also used long time spans of annual data, ranging from 74 to 123 years, to analyse the real exchange rates of 6 countries using a